

N O T I C E

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COMPREHENSIVE DATA REPORT

VOLUME I

DESIGN LAYOUTS

**Commercial Products Division
Pratt & Whitney Aircraft Group
United Technologies Corporation**



N81-17081

Unclass
G3/07 41397

Prepared for
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Lewis Research Center
Under
Contract NAS3-20061

1. Report No. CR-159819		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle Model Aerodynamic Test Results for Two Variable Cycle Engine Coannular Exhaust Systems at Takeoff and Cruise Conditions - Comprehensive Data Report				5. Report Date January 1981	
				6. Performing Organization Code	
7. Author(s) D.P. Nelson				8. Performing Organization Report No. PWA-5550-50	
9. Performing Organization Name and Address Pratt & Whitney Aircraft Group Commercial Products Division United Technologies Corporation East Hartford, Connecticut 06108				10. Work Unit No.	
				11. Contract or Grant No. NAS3-20061	
12. Sponsoring Agency Name and Address NASA Lewis Research Center Cleveland, Ohio 44135				13. Type of Report and Period Covered Contractor Report	
				14. Sponsoring Agency Code	
15. Supplementary Notes Project Manager: A. G. Powers, NASA Lewis Research Center					
16. Abstract Wind tunnel tests were conducted to evaluate the aerodynamic performance of an advanced coannular exhaust nozzle for a future supersonic propulsion system. Tests were conducted with two test configurations: 1) a short flap mechanism for fan stream control with an isentropic contoured flow splitter, and 2) an iris fan nozzle with a conical flow splitter. Both designs feature a translating primary plug and an auxiliary inlet ejector. Tests were conducted at takeoff and simulated cruise conditions. Data were acquired at Mach numbers of 0, 0.36, 0.9, and 2.0 for a wide range of nozzle operating conditions. At simulated supersonic cruise, both configurations demonstrated good performance, comparable to levels assumed in earlier advanced supersonic propulsion studies. However, at subsonic cruise, both configurations exhibited performance that was 6 to 7.5 percent less than the study assumptions. At take-off conditions, the iris configuration performance approached the assumed levels, while the short flap design was 4 to 6 percent less.					
17. Key Words (Suggested by Author(s)) Short Flap Ejector Iris Flap Ejector Coannular Exhaust Nozzle Inverted Velocity Profile				18. Distribution Statement	
19. Security Classif. (of this report) Unclassified		20. Security Classif. (of this page) Unclassified		21. No. of Pages 2226	
22. Price*					

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FOREWORD

This report documents the work performed during the Nozzle Performance Tests (Task III) of Contract NAS3-20061. Because of the large amount of information, this report is presented in three Volumes to facilitate its use.

Volume I contains the design layouts and detailed design drawings of the nozzle models.

Volume II contains the tabular aerodynamic data generated in this program.

Volume III contains a graphical presentation of the data.

A complete description of the test hardware and test facilities is contained in the companion Task III Final Report, CR-159818. Significant test results and conclusions are also included in the Final Report.

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1. Introduction

Design drawings of the Task III nozzle performance test models are presented in this Volume of the report.

Section 2 provides a tabulated list of the model component drawings for each test configuration.

Section 3 contains the layout and detail design drawings.

2. Tabulated Component Drawing Index

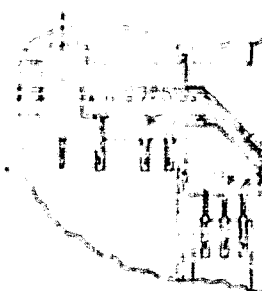
The model drawings are arranged in an order that presents the layout assembly drawings first, followed by the component detail design drawings. The detail drawings are organized in ascending drawing number sequence. The layout drawings show the assembly of the component parts for each test configuration. A listing of the components parts required for each model configuration assembly is provided in Table 2-I.

TABLE 2-I

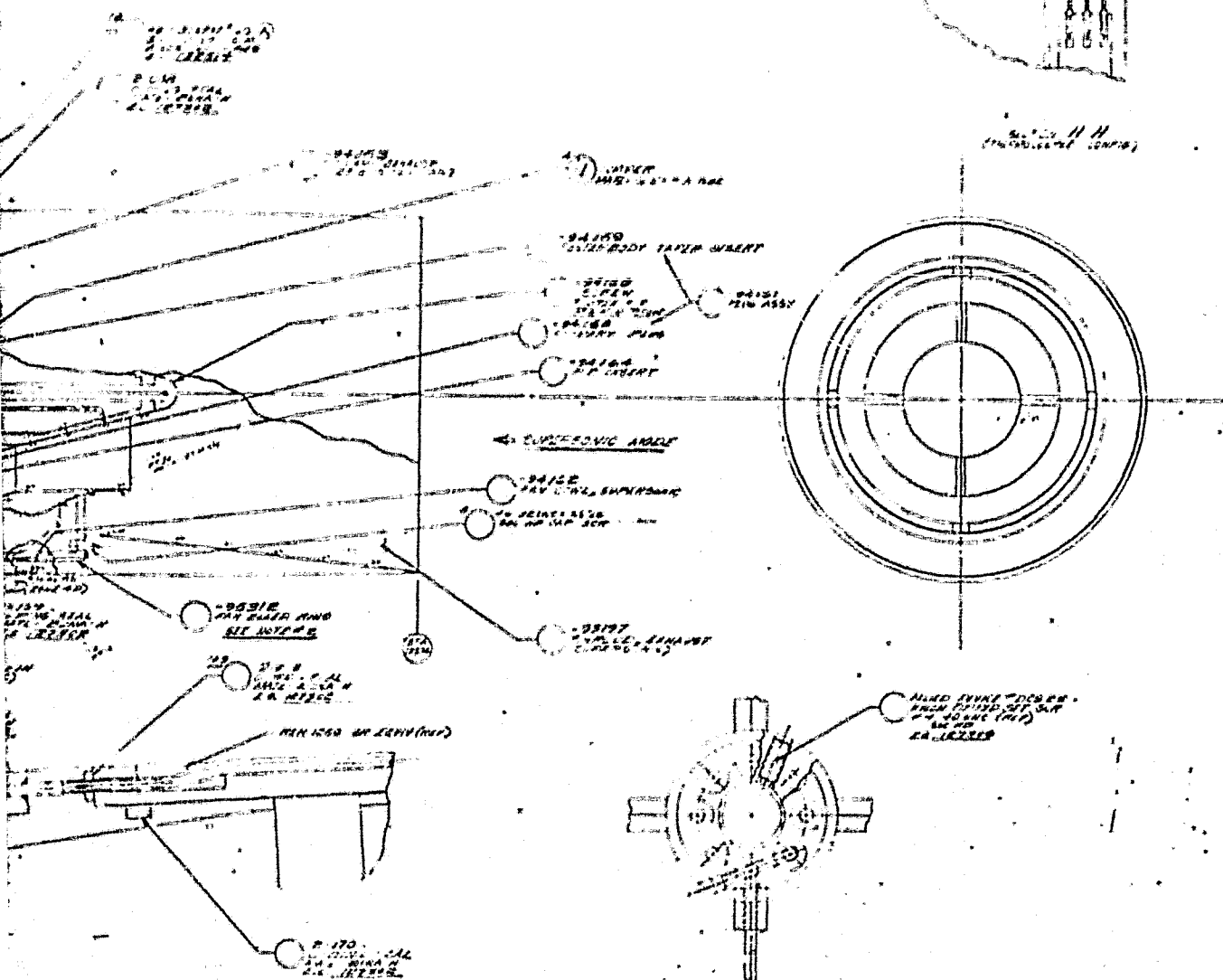
CONFIGURATION ASSEMBLY COMPONENT DRAWINGS

	Short Flap Nozzle Models Layout Assembly Dwg. 1741-1 <u>Component Drawing Number</u>	Iris Flap Nozzle Models Layout Assembly Dwg. 1741-2 <u>Component Drawing Number</u>
o Supersonic Cruise Configuration Components		
Primary centerbody plug assembly	1-94161	1-94161
plug forward end	1-94158	1-94158
plug tapered end	1-94159	1-94159
plug screw	1-94160	1-94160
Flow splitter	1-94153	2-95411
Fan nozzle	1-94162	2-95525
Zero bleed fan nozzle spacer	1-95317	2-95523
Bleed Flow Fan nozzle spacer	1-95312	2-95524
Ejector shroud	1-93197	1-93197
Shroud bleed screw	1-94166	1-94166
Lead-in ring	1-95313	1-95313
o Subsonic Cruise Configuration Components		
Primary centerbody plug assembly	1-94161	1-94161
plug forward end	1-94158	1-94158
plug tapered end	1-94159	1-94159
plug screw	1-94160	1-94160
Flow splitter	1-94153	2-95411
Fan nozzle	1-94163	2-95413
Ejector shroud assembly	1741-3	1741-3
Clam shell	1-94157	1-94157
Lead-in ring	1-95313	1-95313
o Takeoff Configuration Components		
Primary centerbody plug assembly	1-94161	1-94161
plug forward end	1-94158	1-94158
plug tapered end	1-94159	1-94159
plug spacer	2-95521	2-95521
plug screw	2-95522	2-95522
Flow splitter	1-94153	2-95411
Fan nozzle	1-95316	2-95526
Ejector shroud assembly	1741-3	1741-3
Clam shell	1-94157	1-94157
Lead-in ring	1-95313	1-95313

3. DESIGN DRAWINGS



11.000 D. 10.100)



244-21-6-5 SEP 11 1964 (LINE 78)
244-21-6-5 SEP 11 1964 (LINE 78)

VIEW F - F (LINE 20)
CLASS 1.4/1
CONTROL OF JAMES AND MAXIMO
STRENGTH, 2.0 0.75 JAF
1975/1976

2 FOR KILLING PAN FLEE A.M. 5/24/68 10:12
4 TH. 09410) V 2 MAG SEAL (20-1264)
1 SIG RPT. JAT 1 09130 FROM SEAL SWIM 1 HEAD
CALIBRATION FIRE.

~ NOISE ~

The image shows a document with a grid-like structure, possibly a ledger or a record book. The document is heavily obscured by a large, dark, irregular shadow or redaction mark that covers the central portion of the page. The visible text includes names like 'JAMES', 'JANUARY', and 'FEBRUARY'.

FOLDOUT FRAME 2

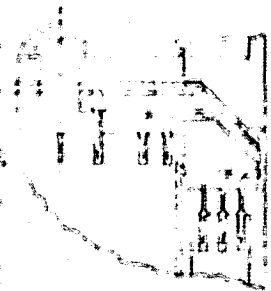
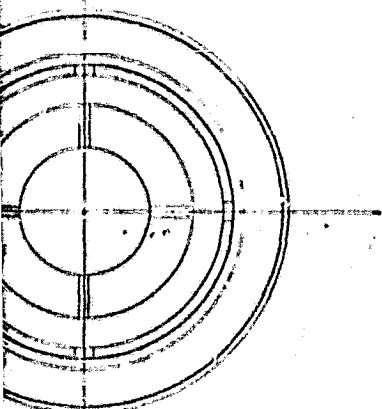


FIG. 11 H
EXHAUST NOZZLE (DETAIL)



ALL DIMENSIONS IN INCHES
UNLESS OTHERWISE SPECIFIED
TOLERANCES (FRACTIONS)
FRACTIONS

A 1741-1

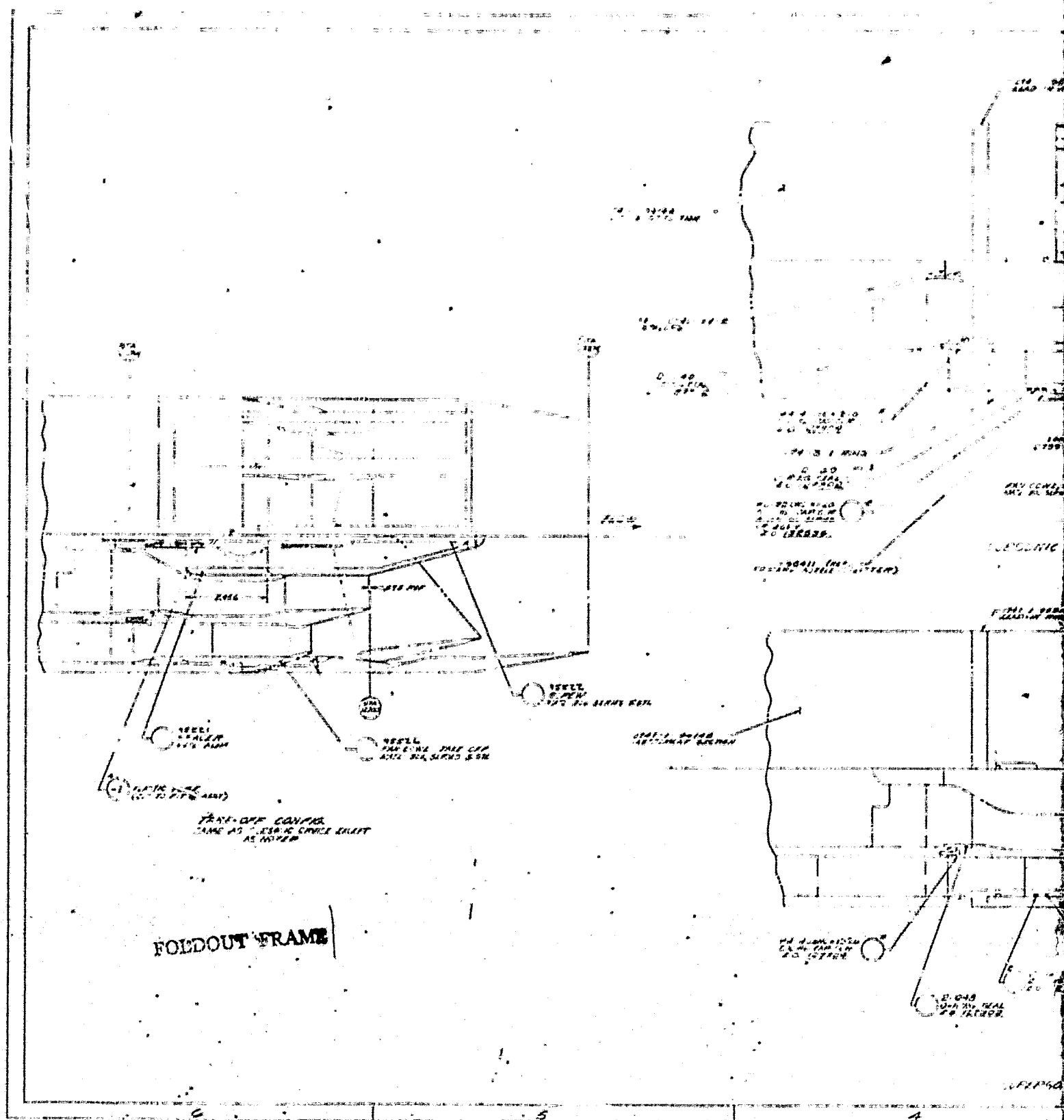
THIS
COPY
REDUCED
1/2

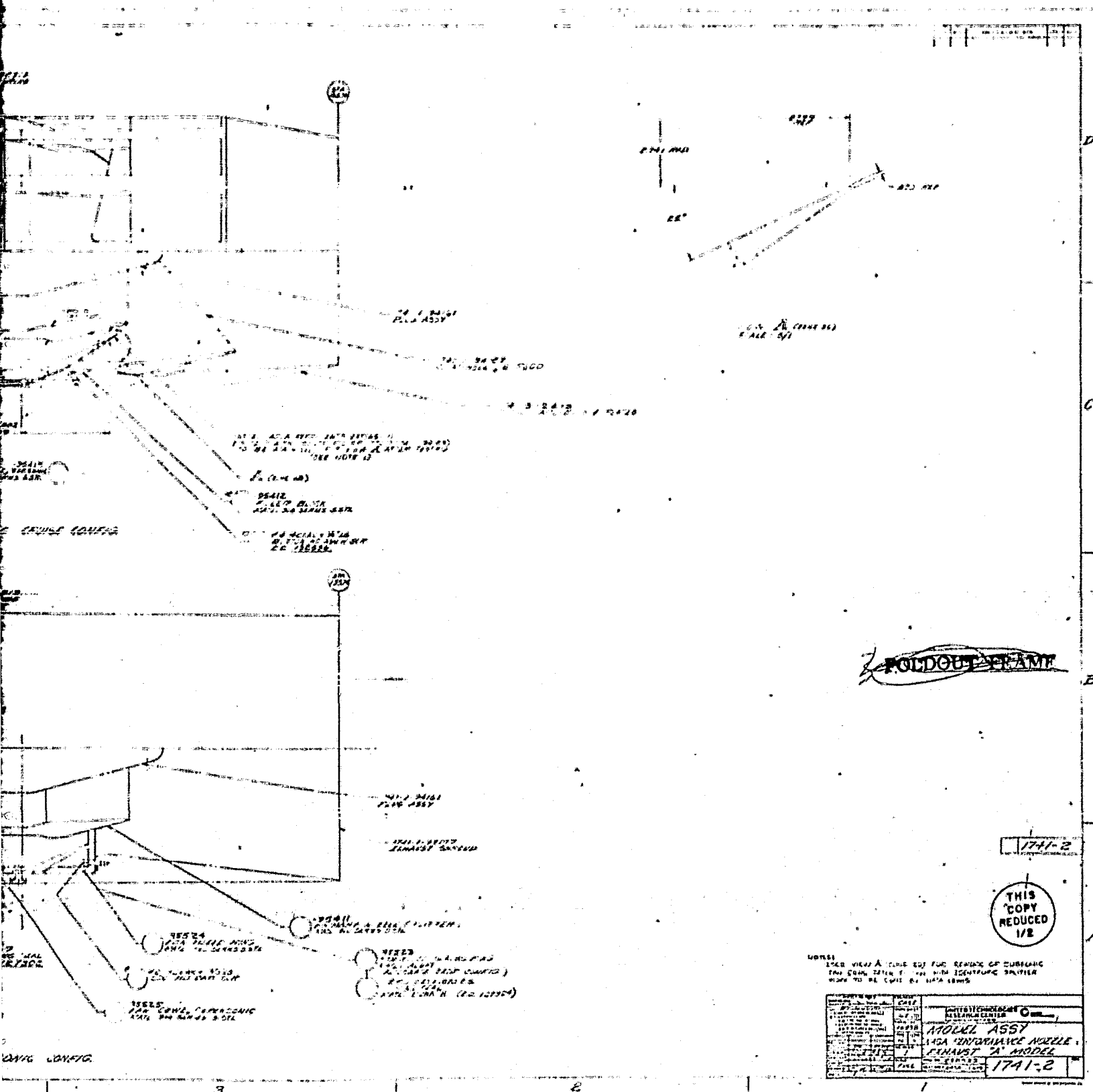
2 FOR BELLING TAN PILED A.P. REFRAC. 10.10.10
1/2 IN. (0.0125) W. 0.0010 IN. (0.0001)
1/2 IN. (0.0125) W. 0.0010 IN. (0.0001)
1/2 IN. (0.0125) W. 0.0010 IN. (0.0001)

NOTES

RESEARCH LABORATORY	
NASA PERFORMANCE NOZZLE	
EXHAUST NOZZLE	
1741-1	

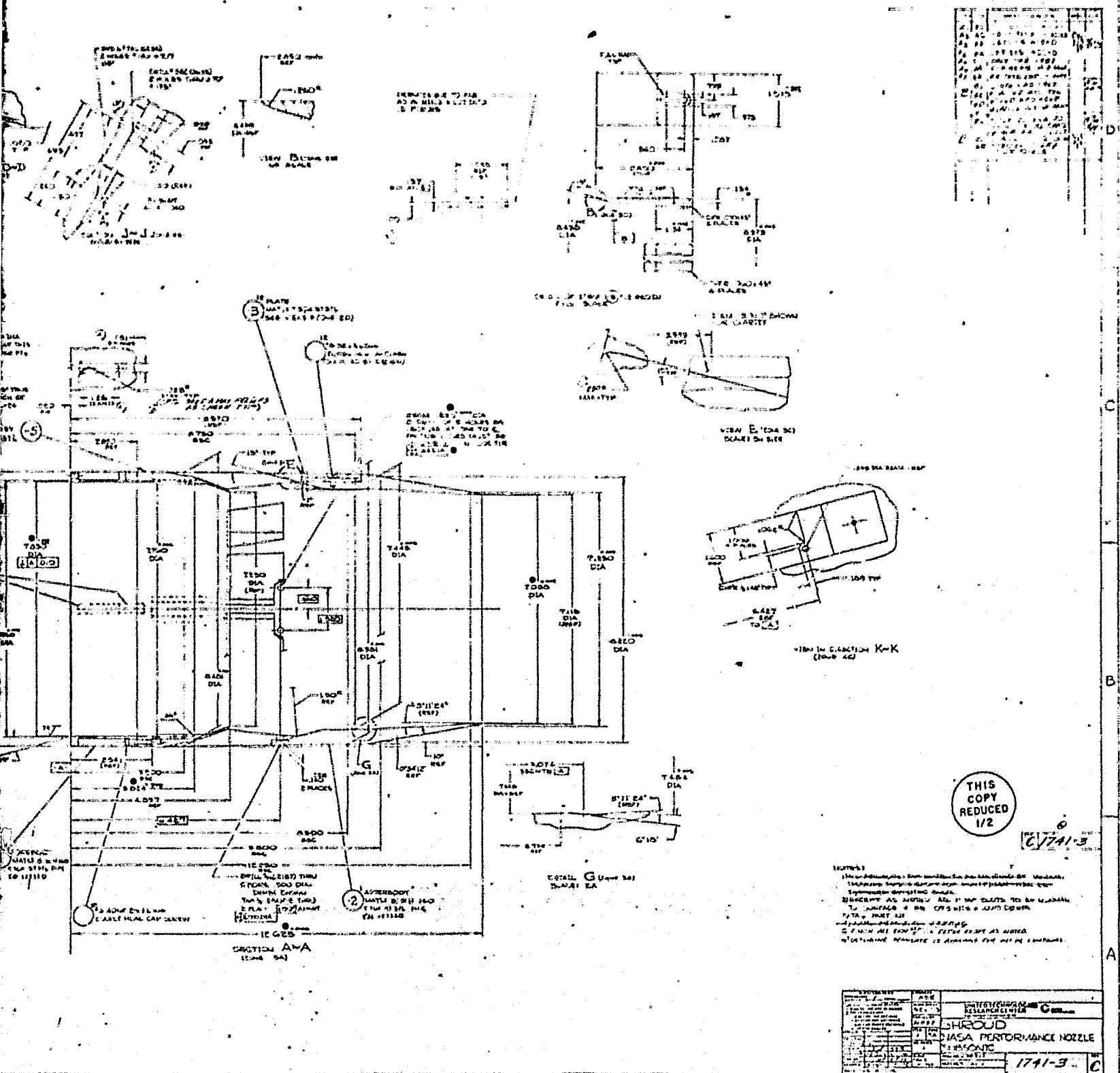
FOLDOUT FRAME





FOLDOUT FRAME

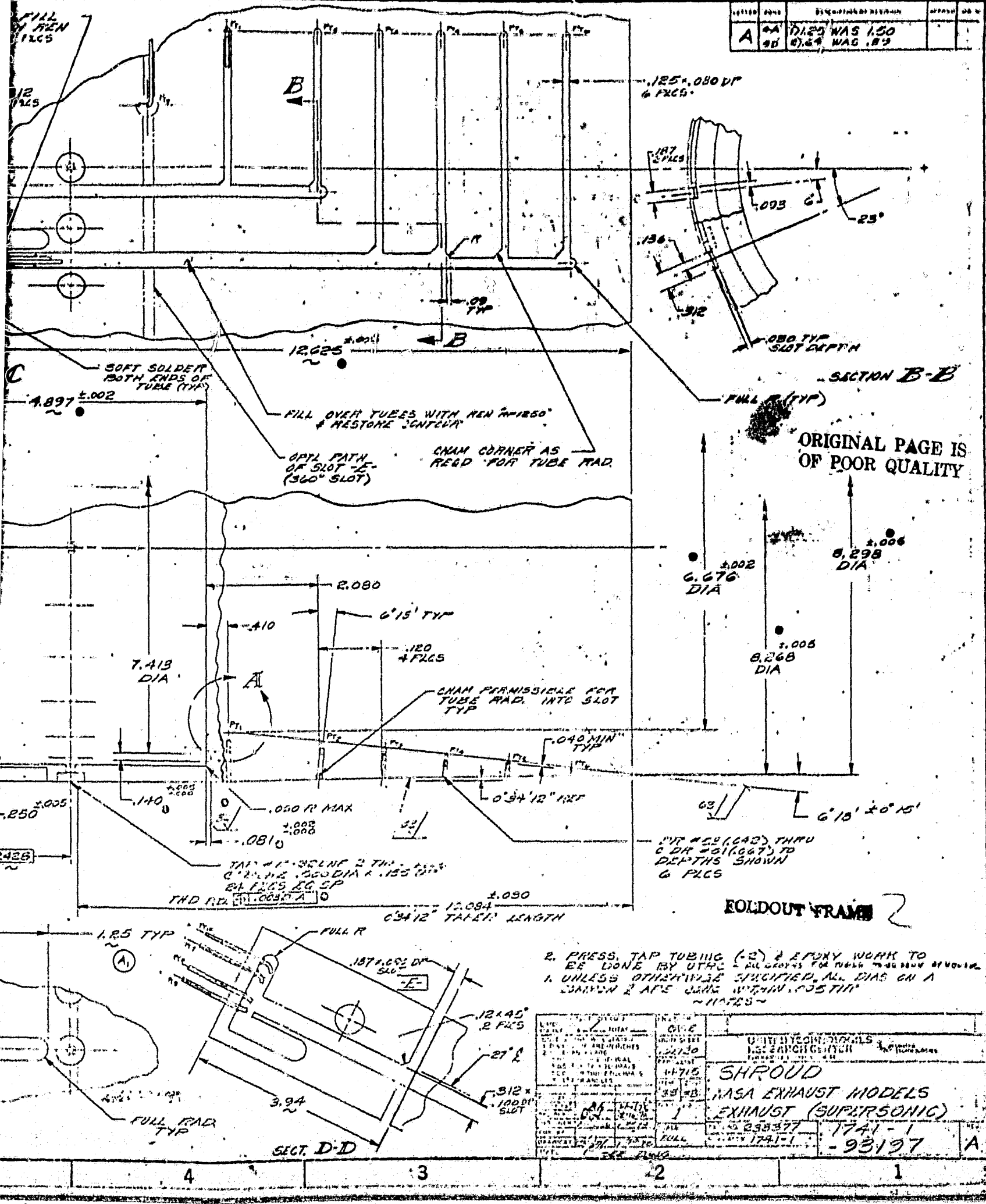
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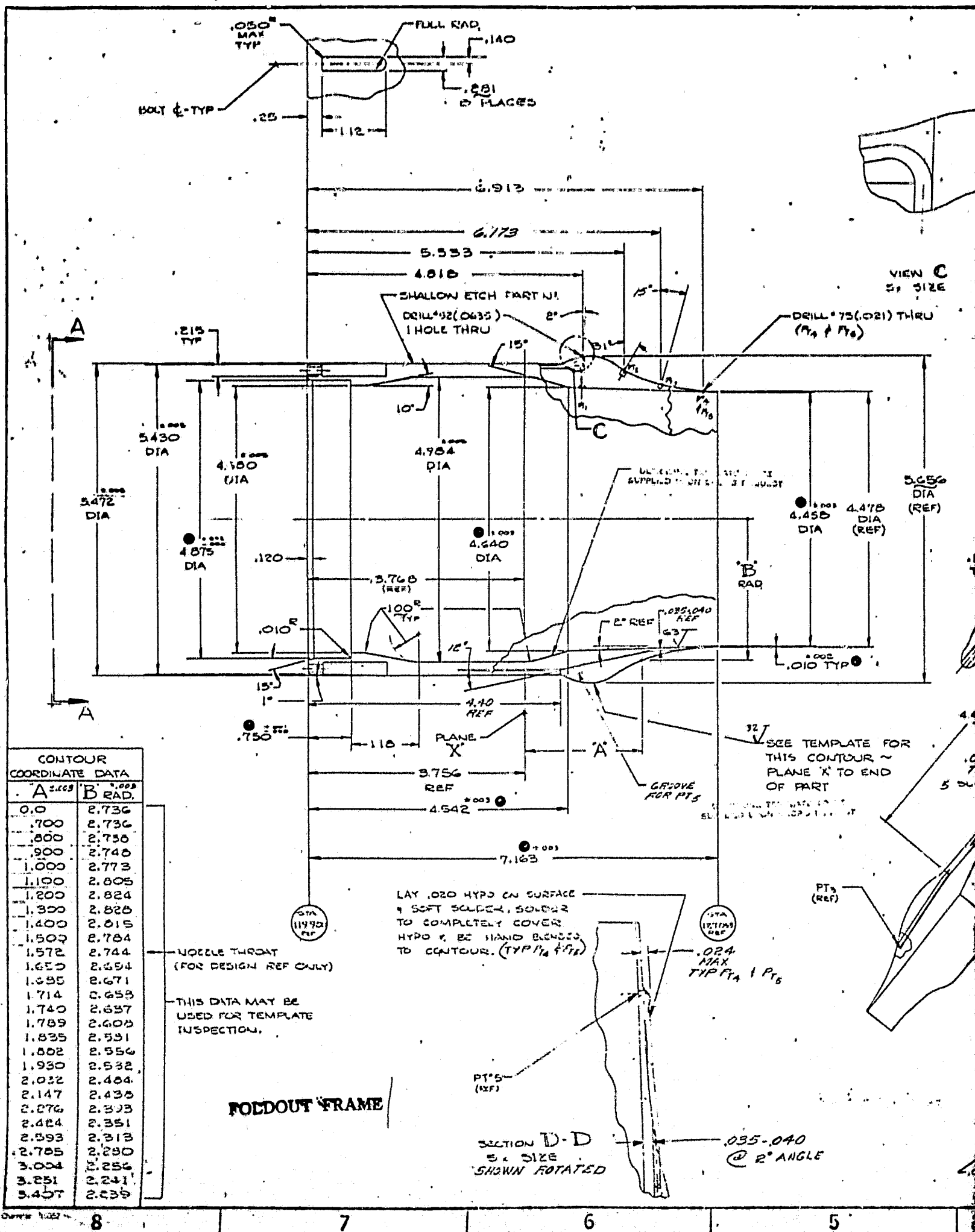


FOLDOUT FRAME

2

REV	DATE	DESCRIPTION OF REVISION	APPROVED	BY
A	11/25/50	WAS 1.50		
B	12/24/50	WAS 1.50		





PT A.

2050

001 DIA

- BREAK EDGE - T
1.008 MAX

ALL AROUND E
A3 S

**SURFACE OF
REVOLUTION**

5.438
RAD.

5.330
RAD.

3704

HAND BLENDING _____
OF THESE CORNERS .125
TO PRODUCE SMOOTH
TRANSITION IS PERMISSIBLE

62°41'50",
(REF)

CONTOUR @ 90° (REF)

SECT A-A

- OUTSIDE CONTOUR IS PRODUCED BY PIVOTING OD SHAPE (INCL. .030 LEADING EDGE RAD.) ABOUT PT 'A' WHILE MAINTAINING .020 EDGE THICKNESS →

PT 'A'
(REF)

1.020
(REF)

- SURFACE OF
REVOLUTION

3.335^R
(REF)

SECT B-B
SECTION PROFILE @ 45°
(ROTATED 45° CW)

FOLDOUT FRAME

EDGE - TYP
MAX

SO
AROUND EXCEPT
AS SHOWN

THIS RAD APPLIES IN
THIS PLANE ONLY

R
704

DRILL & REAM 1/8" DIA
2 HOLES 110 DEEP
(.001 DIA)

.060" R
ALL AROUND
BOTH ENDS

.020
REF

3.538" R
(REF)

PT 'A'
REF

REDUCED
NCL. .050
OUT PT 'A'
EDGE

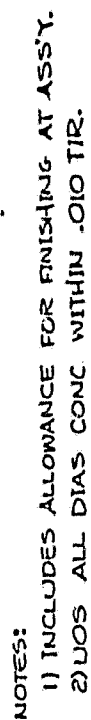
FOLDOUT FRAME


NOTES:

- 1) THIS PART IS
- 2) IT IS PROVIDED FOR PART TO BE FABRICATED AS A FLAT PATTERN DEVELOPMENT THAT IS CALLED ON A MANUFACTURED STRIPS DELIVERED, FINISHED PART MUST CONFORM TO ALL REQTS ON THIS DWG.
- 3) FAB FOR 60 127323
- 4) A SEPARATE SET OF SECTION PROFILE & VARIOUS ANGULAR STATIONS AVAILABLE UPON REQUEST.

DRAWING NO. 1741-1-94157	CASE 1741-1-94157	UNITED STATES RESEARCH CENTER
TITLE CLAMSHELL	PART NO. 1741-1-94157	1741-1-94157
DESCRIPTION NASA PERF. NOZZLE PIVOTING	1741-1-94157	1741-1-94157

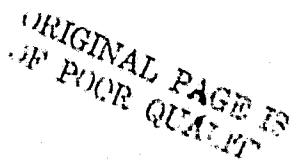
DWG. NO. 1741-1-94157



INSPECTION/RECCO DIMENSIONS MARKED <input checked="" type="checkbox"/> TOTAL		ENGINEER CASE	PLUG	REV	BY	DATE	APR	DWG. NO. 1741-1-941508	REV. 7
UNLESS OTHERWISE STATED 1. DIMENSIONS IN INCHES 2. TOLERANCES ARE • .005 FOR ONE DECIMAL • .010 FOR TWO DECIMALS • .001 FOR THREE DECIMALS • .10 FOR ANGLES		WORK SHEET 76E120	NASA PERF. NOZZLE						
		PARTS LIST 34715	PRIMARY						
		ITEM 31	ZONE 3C	MATERIAL 3" DIA T-3IG ST-5L		PROJ. NO. 2339377			
		NO. REQD 1							
PROF. ENG. CHK. OF DES. DES. SUP. DESIGNER CHK. E.V. DATE	 R. V. SMITH 3/24/72 3/25/72 3/26/72 3/27/72 3/28/72								
UNITED TECHNOLOGIES RESEARCH CENTER East Hartford, Connecticut 06108									



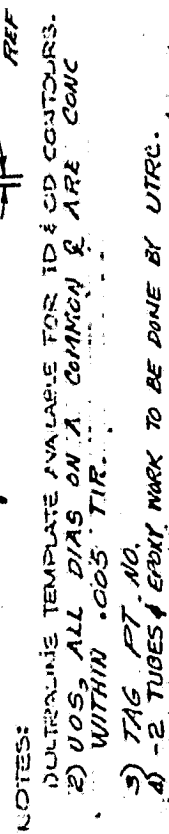
DIMENSIONS MARKED <input checked="" type="checkbox"/> TOTAL UNLESS OTHERWISE STATED 1. DIMENSIONS ARE IN INCHES 2. TOLERANCES ARE DECIMAL 3. .000 FOR TWO DECIMALS 4. .001 FOR THREE DECIMALS 5. .010 FOR ANGLES		INSPECTION REQD MARKED <input checked="" type="checkbox"/> TOTAL		ENGINEER CASE		TAPER END NASA PERF. NOZZLE PRIMARY PLUG MATL 2 1/2 OS T-316 ST-5TL		Dwg. NO. 1741-1-94159		REV. 2	
								DATE BY APP.			
								PROJ. NO. 232377			
				ITEM 32		ZONE 3C		NEXT ASSY 1741-1-94161			
				NO REQD 1							
				SCALE FULL				UNITED TECHNOLOGIES RESEARCH CENTER EAST HARTFORD, CONNECTICUT 06118			

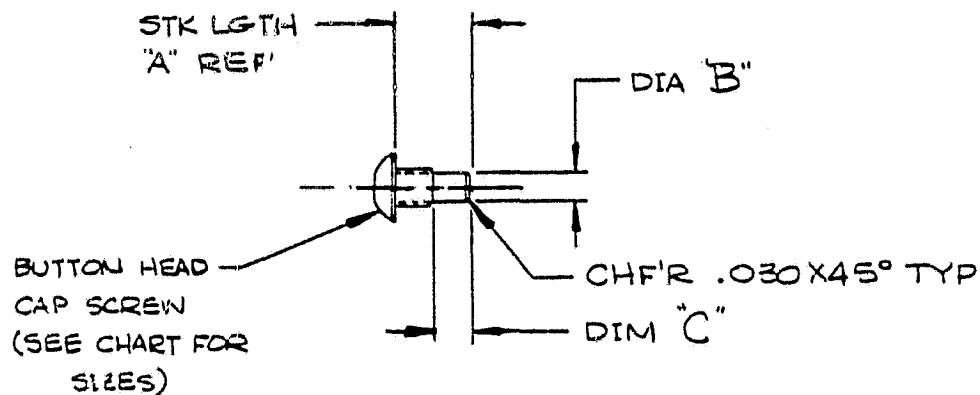


NOTES:
1) DO NOT MARK PART N° OF ASS'Y.
2) PRESS. TAP TUBING TO BE INSTALLED BY UTAC.

[illegible]

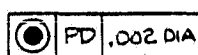
VIEW C
SCALE: 4/1
0-4-1' 34"
REF





ITEM N°	DASH N°	N° REQ'D	'A' REF	DIA "B"	DIM "C"	MAKE FROM
48	-1	2	1/2	.156 ^{+0.003} _{-0.001}	.250	1/4-28 x 1/2
49	-2	24	3/8	.145 ^{+0.003} _{-0.002}	.160	10-32 x 3/8

ITEM SHOWN



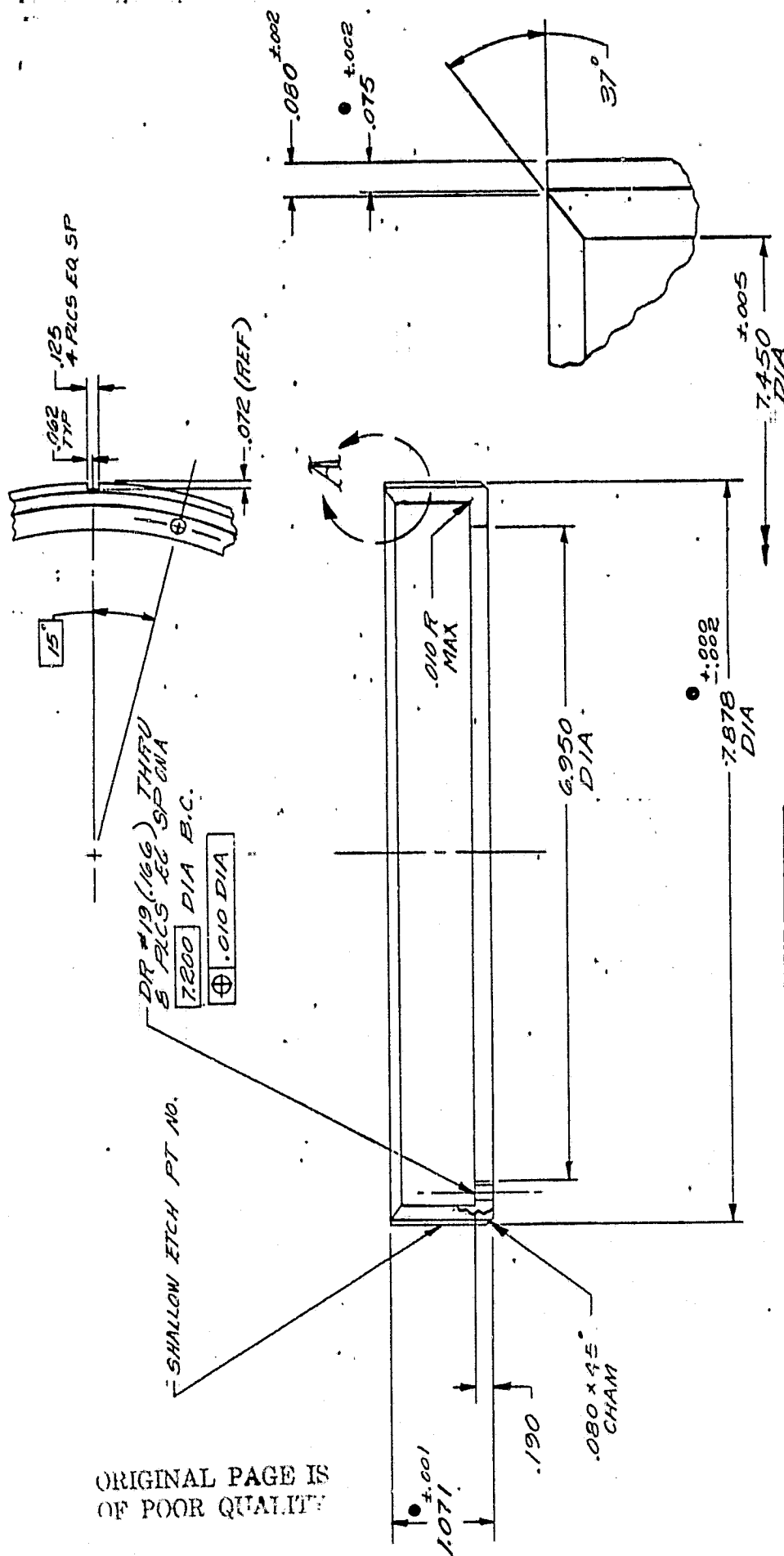
NOTES:

- 1) BAG & TAG PART N°'S

INSPECTION REQ'D DIMENSIONS MARKED <input checked="" type="checkbox"/> TOTAL		ENGINEER CASE	RE	3Y	DATE	APP
UNLESS OTHERWISE STATED 1. DIMENSIONS ARE IN INCHES 2. TOLERANCES ARE - .106 FOR ONE DECIMAL - .003 FOR TWO DECIMALS - .001 FOR THREE DECIMALS - .001 FOR ANGLES		WORK SHEET 76E120	SCREW			
		PARTS LIST 34715	NASA PERF. NOZZLE			
			SPECIAL			
		ITEM SEE ABOVE	MATERIAL SCREWS AS SUPPLIED BY DESIGN			
		COVE -1 813 -2 50	NEXT ASSY 1741-1			
		NO REQ'D	REV. NO. 238377			
PROJ. ENG.		SEE ABOVE				
CH. OF DES.		SEE ABOVE				
CFS SUP		101-3-207				
DESIGNER		1/11/78				
CHK BY		1/11/78				
DRAWN BY		12-27-78				
		SCALE FULL	UNITED TECHNOLOGIES RESEARCH CENTER East Hartford, Connecticut 06108			

1741-1-94160

2

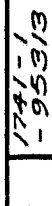


VIEW A
SCALE: 4/1

1) ALL DIAS CONC WITHIN .005 TIR.

~ NOTES ~

DWG. NO. 1741-1-95312		REV.	
ENGINEER G. S. S.	DATE	BY	REV.
WORK SHEET 76E120			
PARTS LIST 34715			
ITEM 40	ZONE 43		
MATERIAL MATL 8' 0.0 X .025 WALL 7-304 SS. 76E120		NEXT ASSY 1741-1	
NO. REQD 1		PROJ. NO. 238377	
SCALE FULL		UNITED TECHNOLOGIES RESEARCH CENTER East Hartford, Connecticut 06108	
INSPECTION REQD MARKED	UNLESS OTHERWISE STATED 1. DIMENSIONS ARE IN INCHES 2. TOLERANCES ARE: ±.006 FOR ONE DECIMAL ±.003 FOR TWO DECIMALS ±.001 FOR THREE DECIMALS ±.10 FOR ANGLES		
APPROVED C. C. S.	DESIGNED G. S. S.		
CHECKED G. S. S.	DESIGNED G. S. S.		
DRAWN BY G. S. S.			



DE 150(070) TNUU
14 HOLE'S LOC ON A
E.E70 D/A B.C.

4.005 DIA

2. TAG. PT NO.
1. ALL DIAS ON A COMMON S ARE CONC WITHIN
.005 TIR.

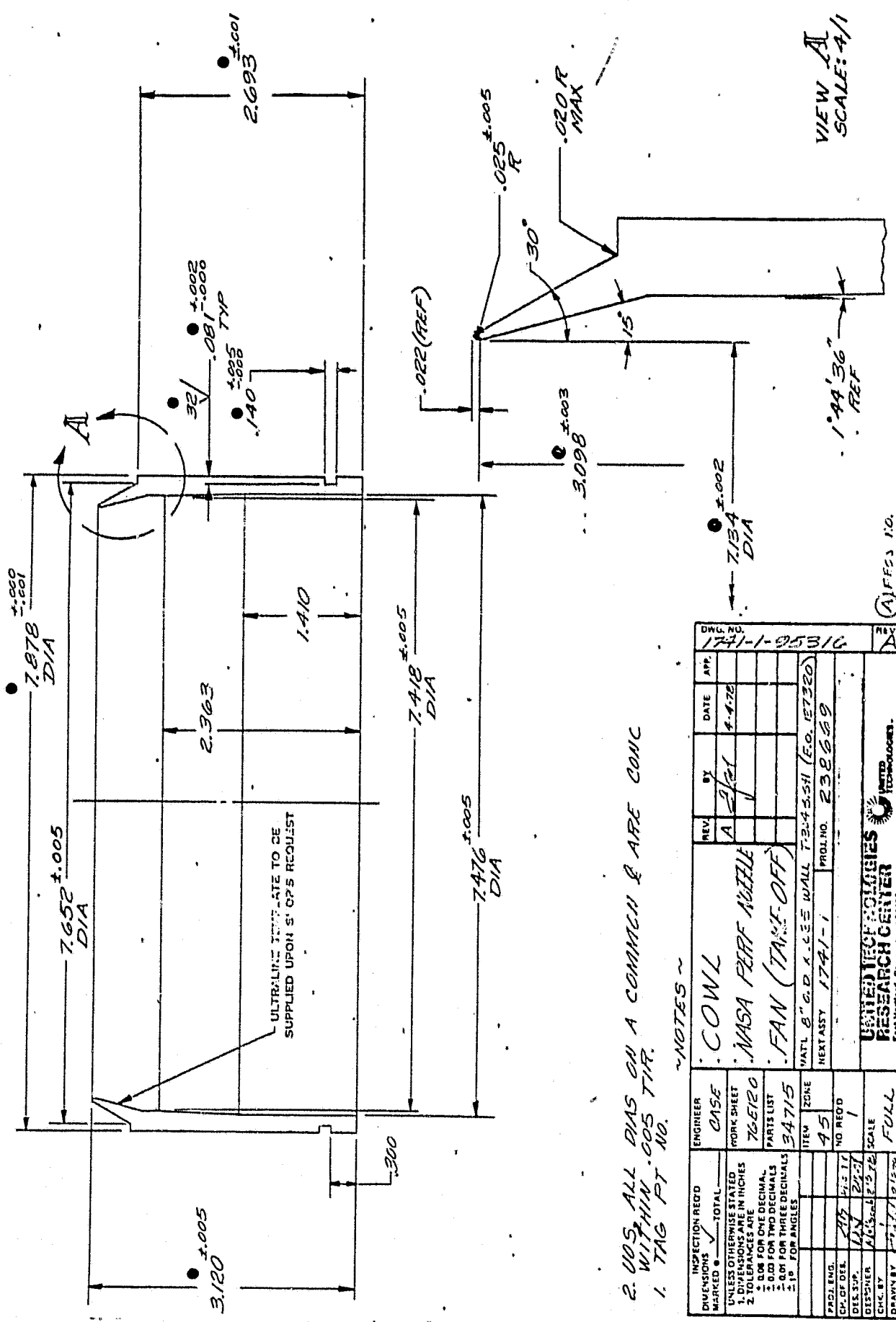
NOTES ~

[illegible]

DR #22(157) THRU
10 HOLES EQ SP ON
A E.250 DIA B.C.

Ⓢ.005 DIA

SECTION A-A

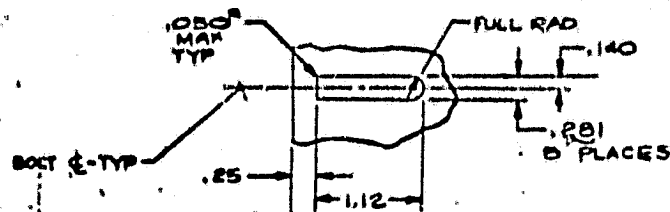


2. UOS. ALL DIMS ON A CONNCH & ARE CONC
 1. TAG PT NO.

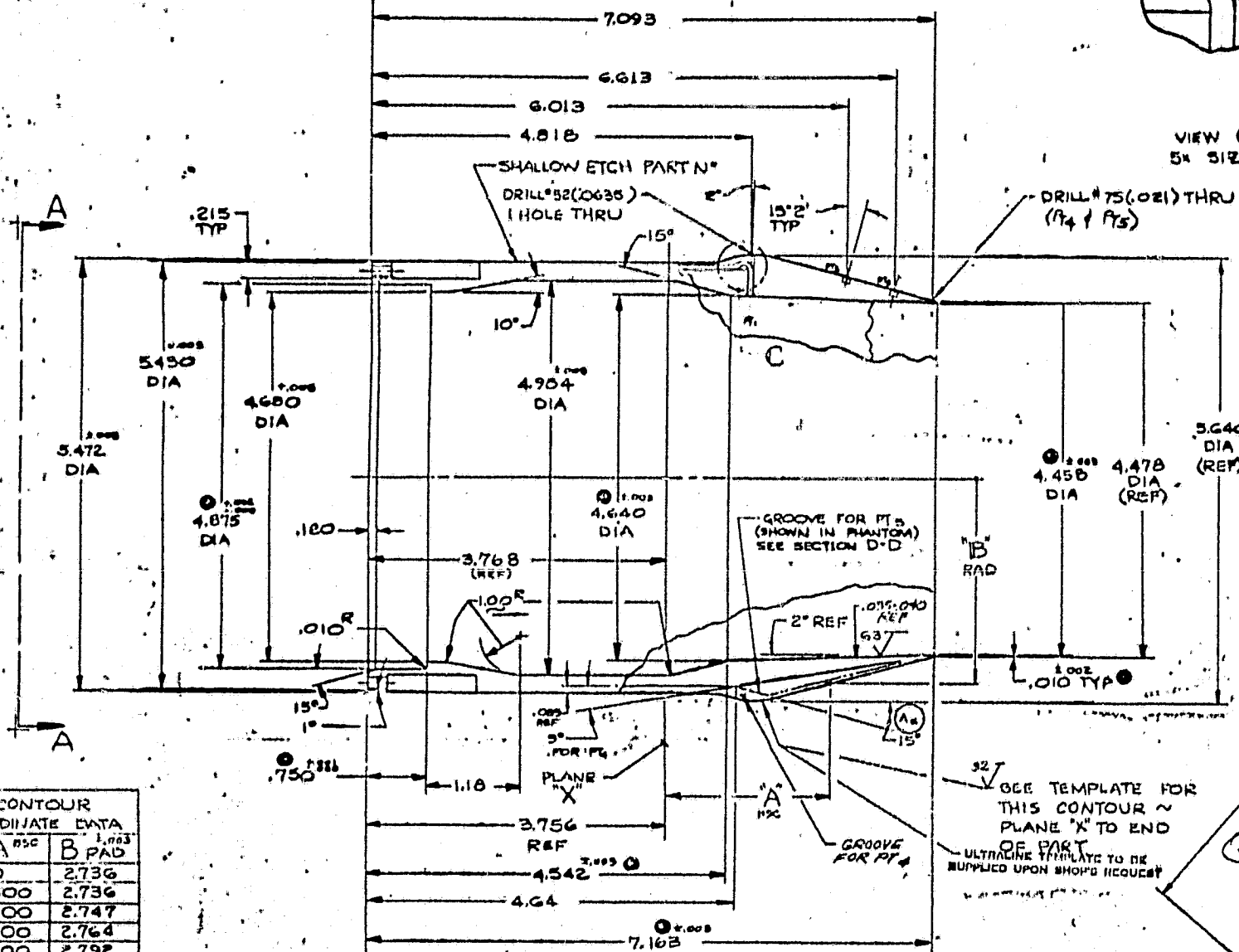
NOTES ~

DWG. NO. 1741-1-95316		REV. NO. A	
DATE 4-4-78	BY A. J. J.	REV. A	APP. A
PROJECT NASA PERFORMANCE		PARTS LIST 34715	
ITEM 45		ZONE 1	
NO. REQD. 1		SCALE FULL	
UNITED TECHNOLOGIES RESEARCH CENTER East Hartford, Connecticut 06108			

VIEW A
 SCALE: 4/1



VIEW C
5X SIZE



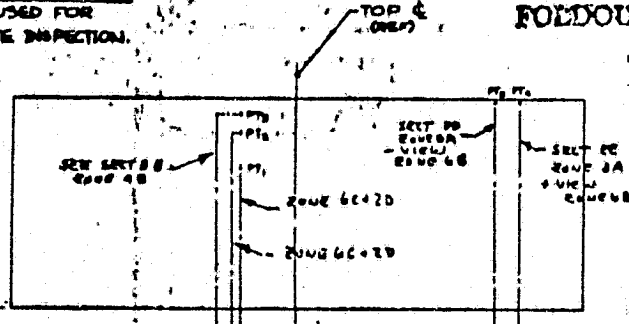
CONTOUR
COORDINATE DATA

A _{MSC}	B _{PAD}
0.0	2.736
0.500	2.736
.700	2.747
.800	2.764
.900	2.792
1.000	2.811
1.100	2.820
1.200	2.819
1.300	2.803
1.350	2.791
1.407	2.239

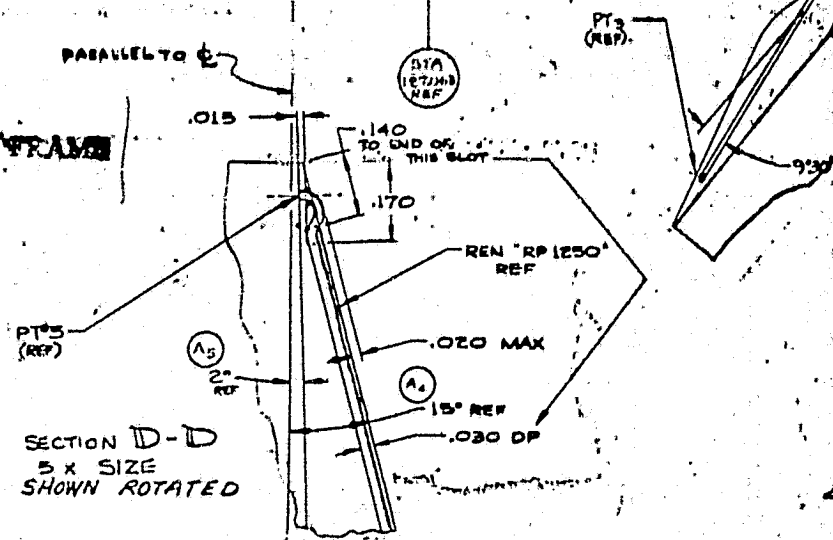
ORIGINAL PAGE IS
OF POOR QUALITY

TO BE USED FOR
TEMPLATE INSPECTION.

FOLDOUT FRAME



DEVELOPED VIEW SHOWING PT
ROUTING (SCALE NONE)



SECTION D-D
5 X SIZE
SHOWN ROTATED

DRILL #52 (.042) THROUGH
1 WALL OF -2 TUBES - TYP
2 PLACES MARKED 'X'

FILL ALL SLOTS WITH REN
PP1250 & RESTORE SURFACE
TO ORIGINAL CONTOUR

CORNER CHAM IN
SLOT PERMISSIBLE

● DRILL #52 (.0635) x 3/4" DP
5 HOLES LOC AS SHOWN
ON A [5.150] BC DIA

SEAL ENDS OF PT₂, PT₃ WITH
SOFT SOLDER

.005 SLOT
TYP UNLESS OTHERWISE
SPECIFIED

DRILL #29 (.136) THRU
B HOLES EQ SP ON A
[5.220] BC DIA
● [10] DIA

2 TUBE
-4 .020 OD x .005 WALL
T-304 ST STL
2 TUBE
-3 .040 OD x .002 WALL
T-321 ST STL - EO 127318

5 PRESSURE TAP
MATL 1/4" OD x .010 WALL
T-304 ST STL HYPENSOFT

3.640
DIA
(REF)

.125
TYP

.1250

.16 TYP

4.40

.085
TYP
5 SLOTS

BODY
MATL: 6.0 DIA
T-304 ST STL
BAR E.O. 132032

.220 TYP
5 PLACES

PAR TO ϕ

SECTION B-B

VIEW IN DIRECTION A-A

REN PP 1250 (REF)

FOLDOUT FRAME

DR 1/32 (.031) THRU (-1)

SECTION E-E
5X SIZE

1. US S₂ ALL DIAS ON A COMMON ϕ ARE
CONC WITHIN .005 TYP

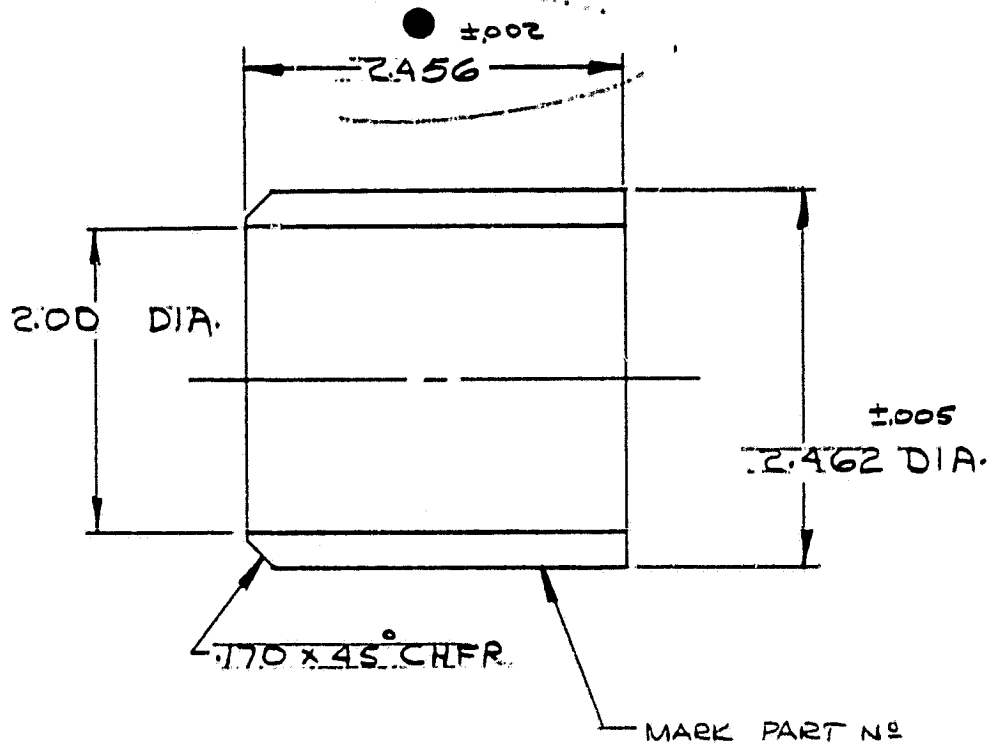
~ NOTES ~

.25 TYP
APP 11
SOFT SOLDER
APP 11
0.027 .010 HYP
0.040 .008 HYP
0.020 .005 HYP
ANNEAL FOR BENDING
DETAIL OF PRESSURE TAP = 4 F 5
NO SCALE

CASE
76B120
NOZZLE
NASA PERFORMANCE MODEL
EXHAUST ~ A MODEL
238669 1741-2
-95411

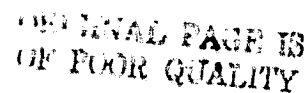
1741-2-95411

A



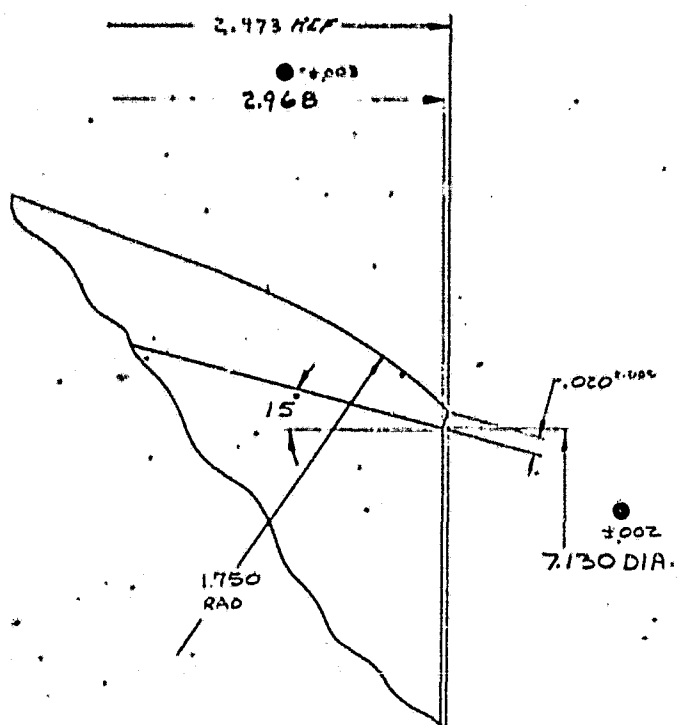
WAS 2.465

INSPECTION REQ'D DIMENSIONS MARKED <input checked="" type="checkbox"/> TOTAL		ENGINEER CASE	SPACER		REV.	BY	DATE	APP.	1741-2-95521
UNLESS OTHERWISE STATED 1. DIMENSIONS ARE IN INCHES 2. TOLERANCES ARE ± .006 FOR ONE DECIMAL ± .003 FOR TWO DECIMALS ± .001 FOR THREE DECIMALS ± 1° FOR ANGLES		WORK SHEET 76E120	NASA PERF. NOZZLE		A	McCoubert	4-28-78	DJL	
		PARTS LIST 36938	TAKE OFF						
		ITEM 3	ZONE 6B	MAT'L 2 1/2 DIA. 6061-T6 ALUM.					
PROJ. ENG.		NO. REQ'D 1		NEXT ASS'Y 1741-2		PROJ. NO. 238669			
CH. OF DES.									
DES. SUP.									
DESIGNER		SCALE FULL		UNITED TECHNOLOGIES RESEARCH CENTER East Hartford, Connecticut 06108					
CHK. BY				UNITED TECHNOLOGIES					
DRAWN BY		3-20-78							

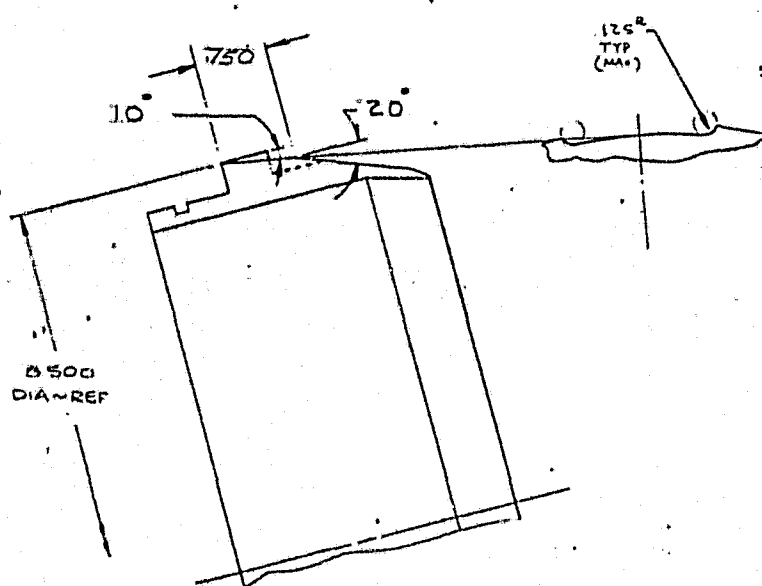


- 1) FINISH MACHINE WITH PART 1741-1-94/59
- 2) SHANK MUST BE STRAIGHT WITHIN .015

INSPECTION REQ'D DIMENSIONS <input checked="" type="checkbox"/> TOTAL <input type="checkbox"/>		ENGINEER CASE	SCREW	REV	BY	DATE	APP
UNLESS OTHERWISE STATED 1. DIMENSIONS ARE IN INCHES 2. TOLERANCES ARE .308 FOR ONE DECIMAL .003 FOR TWO DECIMALS .001 FOR THREE DECIMALS .10 FOR ANGLES		WORK SHEET 76E120	NASA PERF. NOZZLE				
		PARTS LIST 36938	CENTERBODY PLUG				
		ITEM	ZONE	MAT'L T-316 ST-316			
		4	5B	NEXT ASSY 1741-2		PROJ. NO. 238667	
		NO. REQ'D					
PROJ. ENG. [Signature]							
CH. OF DES. [Signature]							
DES. SUP. [Signature]							
DESIGNER [Signature]							
CHK BY [Signature]							
DRAWN BY [Signature]							
		SCALE	FULL				
		UNITED TECHNOLOGIES RESEARCH CENTER East Hartford, Connecticut 06108					

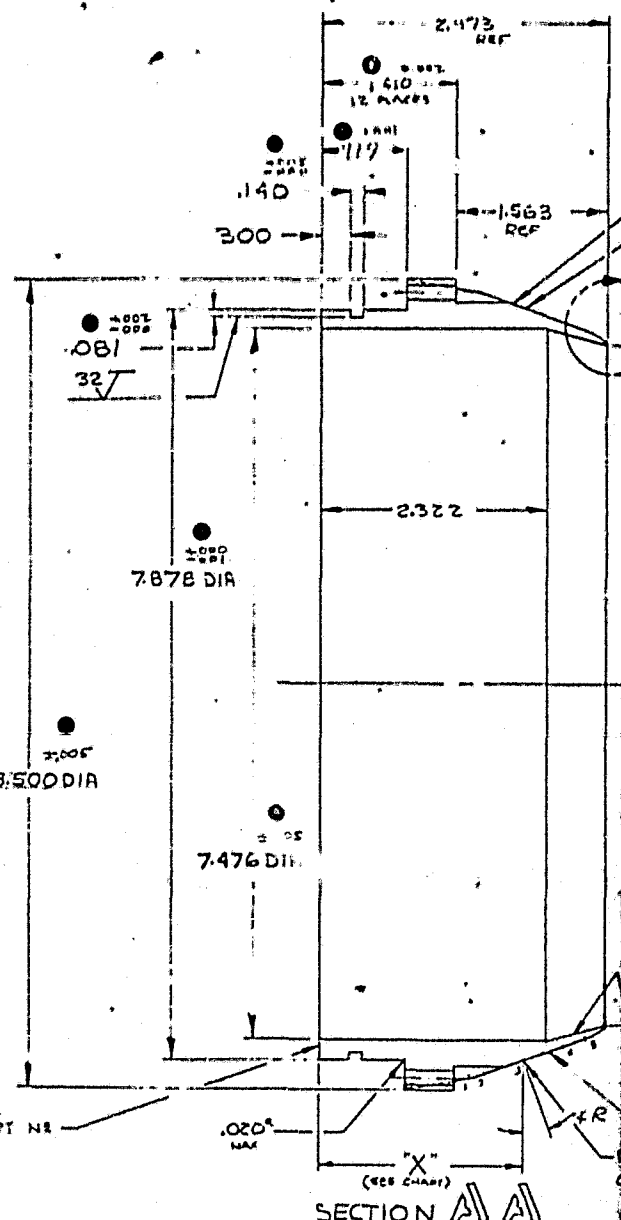


ENLARGED VIEW V
SCALE 10:1



SECTION 1213

FOLDOUT FRAME



PT. NO.	X	± R
1	1.550	10°
2	1.759	20°
3	2.150	20°
4	2.554	23°
5	2.785	27°

THIS SLOT OVER
THIS DISTANCE .0400P

2 TUBE IN THIS AREA
TO BE FLATTENED TO .030
THK FOR PTs ONLY

SEAL ENDS OF TUBES(?)
W/ SOFT SOLDER

VIE
DEVELOP

